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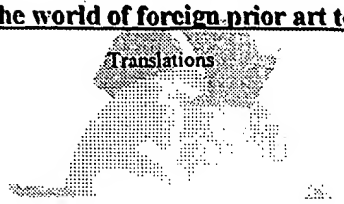

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発明の数　1
審査請求　未請求

（全 4 頁）

⑤④光伝送路途中から情報信号を取り出す方法

⑳特　　願　昭58—85289
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明　細　書

1. 発明の名称　光伝送路途中から情報信号を取り出す方法

2. 特許請求の範囲

(1) 光伝送路途中に半導体材料によるp－n接合を有する活性導波路を挿入し、前記活性導波路を通常順バイアス状態にし、情報信号の取り出しが必要な時に前記活性導波路を逆バイアス状態にして光信号を電気信号として取り出すことを特徴とする光伝送路途中から情報信号を取り出す方法。

3. 発明の詳細な説明

本発明は光の伝送路の途中から情報信号を電気的に取り出す方法に関するものである。

近年、光通信システムの応用範囲の拡大に伴い、種々の新しい機能を持つデバイスの必要性が高まっている。その一つに光伝送路の途中から　号を取り出すためのデバイス（例えばカプラー）が有る。これは光データバス，光ループ等の小規模構内通信システムのように光伝送路に沿って数多くの地点で光伝送信号を得たい場合に特に需要の大きなものである。このようなカプラーを実現するためには将来次の3つの方法が考えられている。

1) 光分岐を用いる方法
2) 光スイッチにより必要な時のみ光信号を検出系に導く方法
3) リピータを用いる方法

これらについて順に簡単に説明する。1)は伝送路途中に光分岐を挿入し、伝送されている光信号の一部を光検出系に導くもので用いるデバイスは非常に安価で簡単であるという利点が有るが分岐により主伝送路の光損失が大きくなるという大きな欠点を有する。2)は1)の光分岐の代りに光スイッチを用いるもので光信号を取り出す必要の無い時には光は殆ど損失無しに伝送されるという利点がある。しかし、現状で実用可能なスイッチでは機械式の場合には挿入損失は小さいが応答速度が遅く、非機械式の場合には一般に速度は速いが用い

る光のモード偏波等に制限が有ったり、挿入損失や形状が大きい等の問題が有り適用の分野が限られてくる。3)は通　の光通信系に用いるリピータと同様に光を一旦検出系によりO/E変換し、電気信号に直した状態で情報信号を次段への光伝送用のE/O変換デバイス（レーザ，発光ダイオード等）駆動回路及び信号検出回路に分けるもので有る。これは系が再生増幅系で有るため、挿入損失は考える必要が無く、伝送中の波形歪の修正も可能であるという利点が有るが、1つのリピータが非常に高価かつ複雑で1つのシステム中に数多く用いる事には価格，信頼性等に問題が有る。

上述のようにカプラーの実現手段として従来考えられているものにはそれぞれ長所，短所が有り最適なものは得られないのが現状である。本発明の目的は、上述のような従来方法の欠点を除き、比較的構成が簡単で安価かつ挿入損失，応答速度も優れた光伝送路途中から情報信号を取り出すための方法を提供することにある。

本発明による光伝送路途中から情報信号を取り出すための方法は光伝送路途中に半導体材料によるp－n接合を有する活性導波路を挿入し前記活性導波路を通常順バイアス状態にし伝搬光を増幅し情報信号の取り出しが必要な時に前記活性導波路を逆バイアス状態にして光信号を電気信号として取り出すことを特徴とするものである。

本発明による方法を具現するには、半導体材料によるp－n接合を有する導波路と前記活性導波路の前後かつ前記活性導波路と光伝送路との間に設置した1対の結合回路と、前記活性導波路に順バイアスを印加するための手段と、前記活性導波路に逆バイアスを印加しかつ光電流を検知するための手段と制御信号に応じ前記活性導波路と前記順バイアスを印加する手段及び、前記逆バイアスを印加しかつ光電流を検知する手段との間の接続を切換える手段を有する装置を用いれば可能である。以下本発明につき図面を用いて詳細に説明する。

一般に半導体材料により形成された導波路で内部のp－n接合への電流注入により反転分布を形成し得る活性導波路ではそのゲインスペクトラムのピーク近傍の波長の光が導波されると導波光が増幅されることが知られている。半導体注入型レーザはこの現象を利用したもので、GaAlAs／GaAs，InGaAsP／InP等の材料によるダブル・ヘテロ接合が利用されている。また、これをレーザとしてではなく外部から注入された光を増幅するための光増幅器に利用することも近年広く試みられてきている。一方半導体中のp－n接合では、逆バイアス印加時には、バンド・ギャップ・エネルギより大きなエネルギを持つ光が吸収された際には、生じた正孔と電子の対が逆バイアス印加により生じた空乏層中をドリフトして横切り光電流を生じる。つまりフォト・ダイオードとしての働きを持つ訳で、この事を利用してSi，Ge，InGaAs等の材料のp－n接合が光検出器として利用されている。

更に、上述の事実は順バイアス　に半導体レーザ，若しくは光増幅器として働くp－n接合を逆バイアス状態で用いれば、順バイアス時に発振若しくは増幅可能な光を検出するフォト・ダイオードとしても用いることが出来る事を示している。実際1つの半導体レーザの中心部にエッチングによる切込みを入れて2分し、一方をレーザ、他方をモニタ用フォト・ダイオードとして用いる試みは既に行なわれている。本発明は上述のように、p－n接合を有する活性導波路が順バイアス，逆バイアス状態に応じて光増幅器，光検出器として利用出来る事を利用したものである。

第1図は本発明の原理を示すための図である。信号伝送用レーザ光1は適当な光学系2によりp－n接合を有する活性導波路3に結合される。ここで活性導波路3の材料としてはレーザ光1の波長が光吸収スペクトルのピーク近傍になるように選ぶ。具体的にはレーザ光1を発生させる半導体レーザと同様の材料によればよい。活性導波路3のp－n接合の両端に順バイアスを加えた　合にはレーザ光1は増幅され出射光4として活性導波路3から出射する。ここで、活性導波路としてはレーザと同様の共振器構造とすることも、進行波

形とすることも可能である。一方、活性導波路3の両端に逆バイアスを印加した場合にはレーザ光1は活性　波路3中を進行中に吸収され外部に光電流として取り出される。従って外部から活性導波路のバイアス状態を電気的に切換えることにより光を増幅して次段へ出射させたり、光を電気信号として取り出したり出来る事になる。このような方法によれば、信号を取り出さない時には光は増幅されるため挿入損失は零若しくはマイナスとする事が出来、切換え・応答速度は充分高いものが期待出来る。またリピータのような複雑な構成ではないため簡便で、安価な光伝送路途中から情報信号を取り出す方法が得られることになる。

第2図は本発明による、光伝送路途中から情報信号を取り出す方法を具現するための装置の一実施例を示す図である。光伝送路10a（ここでは光ファイバを想定）中を伝送され出射したレーザ光11aは結合回路12aによりp－n接合を有する活性導波路3に結合される。活性導波路3からの出射光11bは結合回路12bにより再び光伝送路10bに結合され伝送される。活性導波路3のp－n接合電極には切換回路13を介して、順バイアス印加回路16及び、逆バイアス印加回路14が接続され切換回路13に加える制御　号によりp－n接合のバイアス状態が切換えられる。既に説明したように、切換回路13を順バイアス印加回路16側に接続した場合には活性導波路3の出射光11bは増幅され光伝送路10b中へ結合され伝送される。この状態では光は増幅されるため結合回路12a，12bに結合損失が有っても充分それを補償することが出来、挿入損失は考えなくてもよい。次に光信号の検出が必要になった場合には切換回路13を切換え、活性導波路3を逆バイアス印加回路16に接続する。この場合には光は活性導波路3中を伝搬中に吸収され正孔－電子対を発生するため伝送されていた光信号は光電流として端子15に出力され光信号の検出が可能となる。ここで逆バイアス印加回路14，順バイアス印加回路16としては通常のフォト・ダイオード，半導体レーザを使用する時と同様の極く簡単な回路を用いることが出来る。また切換回路13は通常の電気デバイスによるスイッチング回路を用いても充分高い応答速度が期待出来る。活性導波路3としては通常用いられている半導体レーザと同様の構造材料の物が適している。つまり材料としてGaAlAs／GaAs，InGaAsP／InPを用いたダブル・ヘテロ接合若しくはマルチ量子井戸構造等を有する物が適している。また既に述べたように活性導波路3としては半導体レーザと同様の共振器型とすることも進行波型とすることも可能である。第2図に示した実施例では結合回路12a，12bを活性導波路3と別々の構成としたが、活性導波路3と同一の基板上に低光吸収組成の半導体若しくは誘電体等により一体に集積化することも可能でその場合には製作時の調整の容易度，長期の位置ずれに対する安定性などの点で有利となる。

以上詳細に説明したように本発明によれば比較的　成が簡単で、応　速度が速く、挿入損失も優れた光伝送路途中から情報信号を取り出す方法及びその装置が得られる。

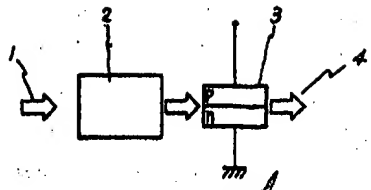
4. 図面の簡単な説明

第1図は本発明による光伝送路途中から情報信号を取り出す方法の原理を説明するための図、第2図は本発明による光伝送路途中から情報信号を取り出す方法を具現するための装置の一実施例を示す図である。

図に於て、1，4，11a，11bはレーザ光，2，12a，12bは結合回路，3は活性導波路，10a，10bは光伝送路，13は切換回路，14は逆バイアス印加回路，15は端子，16は順バイアス印加回路である。

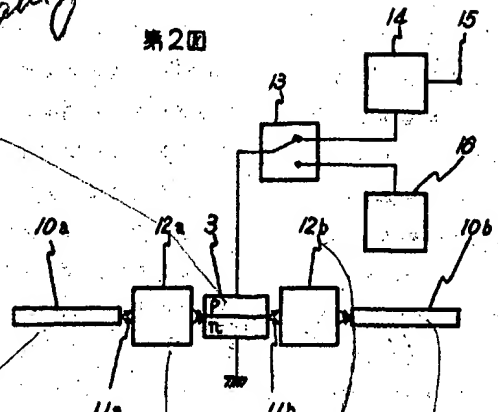
代理人 弁理士 内原　晋

第1図



active waveguide path

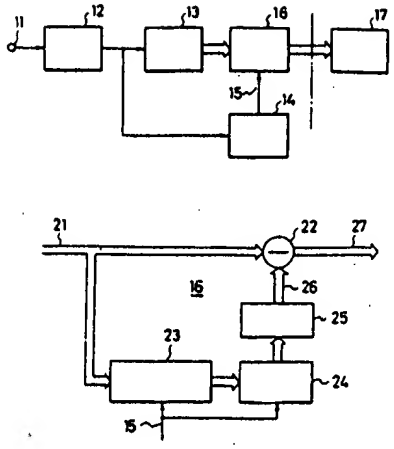
第2図



coupled circuit

light transmission path

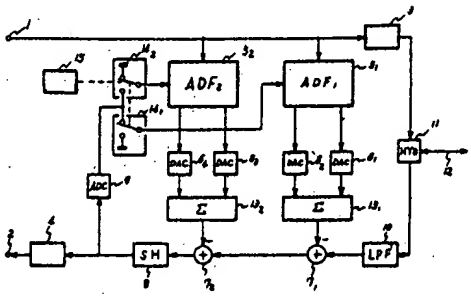
(54) LEVEL SHIFT CIRCUIT
(11) 59-211335 (A) (43) 30.11.1984 (19) JP
(21) Appl. No. 58-86056 (22) 17.5.1983
(71) TOSHIBA K.K. (72) KAZUO OOZEKI
(51) Int. Cl³. H04B3/04,H03K5/00,H04N7/08



PURPOSE: To attain stable equalizing operation and decoding by detecting zero level of a signal digital waveform multiplexed with an analog signal and subtracting this zero level from an input signal to attain level shift.

CONSTITUTION: A signal is inputted to a timing circuit 14 via an AGC circuit 12 and an A/D converter 13 and the circuit 14 detects a multiplex position of a character signal and gives a timing signal 15 whose level is inverted during the period representing the multiplex position to a level shift circuit 16. A character signal 21 inputted from the converter 13 is supplied to a waveform memory 23 and a subtractor 22 in the circuit 16 and an operation processing circuit 24 detects a zero level of the character signal by reading the signal 21 from the memory 23 in the timing given by the signal 15. This zero level is stored in a memory 25 as a shift level, and this shift level 26 is subtracted from the signal 21 by the subtractor 22. Further, a character signal 27 whose level is shifted is subjected to distortion correction by a waveform equalizer 17.

(54) ECHO CANCELLER DEVICE
(11) 59-211338 (A) (43) 30.11.1984 (19) JP
(21) Appl. No. 58-86181 (22) 17.5.1983
(71) NIPPON DENKI K.K. (72) AKIRA KANEMASA
(51) Int. Cl³. H04B3/23

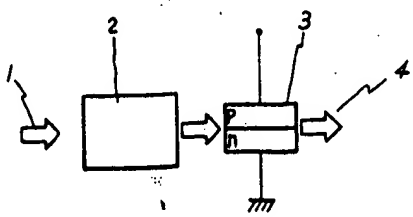


PURPOSE: To decrease the required number of bits of a D/A converter by providing two adaptive digital filters and canceling roughly echo by one filter and then canceling the remaining echo by the other.

CONSTITUTION: An output of the D/A converter 9 is inputted to the adaptive digital filter (ADF_1)5_1 via switches 14_1, 14_2 by a signal from a timing generating circuit 15. An output of the $ADF_1 5_1$ is supplied to an adder 13_1 via D/A converters 6_1, 6_2 and an echo replica depending on the transmission data supplied to an input terminal 1 appears at an output of the adder 13_1. In the 2nd step next, the switches 14_1, 14_2 are switched, an output of the converter 9 is given to the adaptive digital filter (ADF_2)5_2, which starts an operation properly. This is operated so as to decrease the residual echo appearing at the output of a subtractor 7_1.

3: transmission section, 4: receiving section, 12: 2-wire transmission line

(54) METHOD FOR EXTRACTING INFORMATION SIGNAL ON THE WAY OF OPTICAL TRANSMISSION LINE
(11) 59-211339 (A) (43) 30.11.1984 (19) JP
(21) Appl. No. 58-85289 (22) 16.5.1983
(71) NIPPON DENKI K.K. (72) MASAHIKO FUJIWARA(2)
(51) Int. Cl³. H04B9/00,H01L31/02



PURPOSE: To decrease inertion losses and to quicken the response speed by inserting an active waveguide path having P-N junction in an optical transmission line and amplifying propagated light with a forward bias normally to extract the optical signal as an electric signal at a reverse bias.

CONSTITUTION: Laser light 1 for signal transmission is coupled with the active waveguide device 3 having the P-N junction via an optical system 2. In applying a forward bias across the P-N junction of the waveguide path 3, the laser light 1 is amplified and irradiated from the waveguide path 3 ad irradiated light 4. On the other hand, in applying a reverse bias across the waveguide path 3, the laser light 1 is absorbed while being travelled through the active waveguide path 3 and extracted externally as a light current. Thus, the light is amplified and irradiated to the next stage or the light is extracted as the electric signal by changing over the bias state of the waveguide path 3 in this way.

PTO: 2001-4427

Japanese Published Unexamined Patent Application (A) No. 59-211339, published November 30, 1984; Application Filing No. 58-85289, filed May 16, 1983; Inventor(s): Masahiko Fujiwara et al.; Assignee: Nippon Electric Corporation; Japanese Title: Method to Extract Data Signals from Light Transmission Path at Some Point Along the Path.

METHOD TO EXTRACT DATA SIGNALS FROM LIGHT TRANSMISSION PATH AT SOME POINT ALONG THE PATH

CLAIM(S)

A method to extract a data signal as an electrical signal from a light transmission path at some point along the path by inserting an active waveguide path having a p-n junction made of semiconductor material into the light transmission path at some point along the path, putting said active waveguide path into a normal bias state, and putting said active waveguide path into a reverse bias state when the data signal is extracted.

DETAILED DESCRIPTION OF THE INVENTION

The present invention pertains to a method to electrically extract data signals from a light path at some point along the path.

Along with recent extended applications of an optic communication system, new devices having various functions are highly demanded. One of them is a device (generally called coupler) that extracts signals from a light transmission path at some point along the path. This device is demanded for use in extracting optical

transmission signals at multiple points along the optical transmission path in small intra communication system such as an optical data bus or optical loop. To embody such a coupler, the following 3 methods can be considered.

1) Method for using a light splitter.

2) Method for detecting the light signals by an optical switch only when needed.

3) Method for using a repeater.

They are explains in detail below. In method 1), a light splitter is inserted at some point along the transmission path, and the light signal being transmitted is guided to a photo-detector system. With this method, the device used is very inexpensive and simple, but the insertion of a splitter causes a problem of a loss of light in the main transmission path. In method 2), a light switch is used in stead of a light splitter. This comes with an advantage that the most of the light is transmitted without loss when there is no need of extracting the light signal. At present, however, the usable switch has a low response, although there is not much loss in case of mechanical insertion. With a non-mechanical method, the speed is fast but there are problems of limiting the light mode, polarized electromagnetic radiation, and insertion loss, which results in limiting its application. In method 3, the light is O/E converted once into the electrical signal by the detection system, as in a repeater used for general optic communications system. Then, the data signal put into the electrical signal is allocated to a driving circuit and a signal detection circuit of the

E/O converting device (laser or light-emitting diode) for the subsequent light transmission. This device is a reproduction amplifying device, so the insertion loss needs not be taken into consideration, and the deformed waveform can be corrected, which is advantageous. However, one unit of repeater is very expensive and complex, and the need of many repeaters for one system is problematic in terms of cost and reliability.

As mentioned above, the prior art coupler comes with strengths and weaknesses, and there has never been an appropriate one available. The present invention, to eliminate the aforementioned problems, attempts to present a method to extract data signals from a light transmission path, which is simply structured, inexpensive, and excellent in response speed without an insertion loss, at some point along the path.

In the method to extract the data signal from the light transmission path at some point along the path, an active waveguide path having a p-n junction made of semiconductor is inserted in the light transmission path at some point along the path; the active waveguide path is put into a forward bias state to amplify the transmitted light; and the active waveguide path is put into a reverse bias state to extract the light signal in form of electrical signal.

To embody the method of the present invention, it is necessary to use a device that comprises: a pair of coupled circuits installed before and after the active wave

guide path having a p-n junction and between the light transmission path and the active waveguide path; a means to charge the forward bias into the active waveguide path; a means to charge the reverse bias into the active waveguide path and detect the optical current; a means to switch the connection between the means to charge the forward bias to the active waveguide path and the means to charge the reverse bias and detect the optical current, according to the control signal. The present invention is explained below with reference to the drawings.

With the active waveguide path, wherein the reverse distribution can be formed by current supply to the p-n junction inside the waveguide path made of general semiconductor material, it is known that the guided light is amplified when the light with a wavelength near the gain spectrum is guided. The semiconductor imbedded type laser takes advantage of this phenomenon, and a double hetero junction made of GaAlAs/GaAs or InGaAsP/InP in particular is used. It has recently been attempted to use this as a light amplifier for amplifying the externally supplied light rather than a laser. On the other hand, with the p-n junction in a semiconductor, when the light having energy higher than band gap energy at a time of charging the reverse energy, a pair of electron and generated positive hole drifts across the depletion layer generated by the reverse bias charging, and generate the optical current. In other words, this works as a photo-diode, and by using this advantage, the p-n junction made of materials, Si, Ge, and InGaAs is used as a light

detector.

Moreover, the above fact shows that, if the p-n junction that works as a light amplifier or semiconductor laser in forward bias state, it can also be used as a photo-diode for detecting the light that can be amplified or oscillated in forward bias state. It is already attempted that a semiconductor laser is divided into two parts by etching the center and one side is used as a laser while the other side is used as a photo-diode for monitoring. As mentioned above, in the present invention, the active waveguide path with a p-n junction can be used as a light amplifier or light detector depending upon the forward bias or reverse bias state.

Fig. 1 shows a diagram indicating the theory of the present invention. The signal transmitting laser light 1 is coupled to active waveguide path 3 having the p-n junction by appropriate optical system 2. As for the material of active waveguide path 3, it is selected based on such a condition that the wavelength of the laser 1 comes near the peak of the light absorption spectrum. More specifically, the same material as that of the semiconductor laser generating the laser light 1 can be used. When the forward bias is charged into both ends of the p-n junction of active waveguide path 3, laser light 1 is amplified and emitted from the active waveguide path 3 in form of emission light 4. Therefore, the active waveguide path can have a resonance structure like that of the laser, or an advancing waveform. On the other hand, when the reverse bias is charged into both ends of the active waveguide path

3, the laser light 1 is absorbed while advancing inside the active waveguide path 3 and is output to the outside as a photo electric current. Accordingly, the light is amplified and emitted to the following stage by electrically switching the bias state of the active waveguide path, from the outside, and the light can be output in form of electrical signal. By this method, when the light is not extracted, the light is amplified, so the insertion loss is 0 or negative, and the response speed and switching can be very fast. The structure is not so complex as in the case of using the repeaters, so the data signal can be extracted from the convenient and inexpensive light transmission path at some point along the path by the method of the present invention.

Fig. 2 shows a diagram of one example to embody the method to extract the data signal from the light transmission path at some point along the path in the present invention. The laser light 11a emitted from the light transmission path 10a (presumed to be an optic fiber) is coupled with active waveguide path 3 having the p-n junction by the coupled circuit 12a. The emitted light 11b from the active waveguide path 3 is again coupled to the light transmission path 10a by the coupled circuit 12b and is transmitted. To the p-n junction electrode of the active waveguide path 3, the forward bias charging circuit 16 and reverse bias charging circuit 14 are connected via the switching circuit 13, and by the control signal supplied to the switching circuit 13, the bias status of the p-n junction is switched. As explained

above, when the switching circuit 13 is connected to the forward bias charging circuit 16, the emitted light 11b from the active waveguide 3 is amplified and supplied to the light transmission path 10b and transmitted. Under this condition, the light is amplified, therefore, can compensate the coupling loss in the coupled circuits, 12a, 12a, even if the loss occurs, so the insertion loss needs not be considered. When the light signal needs to be detected, the switching circuit 13 is switched to connect the active waveguide path 3 to the reverse bias charging circuit 16. In this case, the light is absorbed while being guided in the active waveguide path 3, generating the positive hole - electron pair, so the light signal transmitted is output to the terminal 15 as an electrical current, allowing the light signal detection. For the reverse bias charging circuit 14, forward bias charging circuit 16, a general photo diode, and a semiconductor laser can be used, or a similar simple circuit can be used. Also, even if the switching circuit 13 uses a switching circuit made by a normal electric devise, sufficiently high response speed can be expected. As for the active waveguide path 3, the one made of material generally used for a semiconductor laser is appropriate. More specifically, an appropriate material is the one having a double hetero junction or multi-quantum well structure made of GaAlAs/GaAs or InGaAsP/InP is appropriate. As explained earlier, the active waveguide path 3 may be a resonator type similar to a semiconductor laser, or can be an advanced waveform type. In the embodiment example of Fig. 2, the coupled

circuit, 12a, 12b, are separately structured from the active waveguide path 3, but it is possible that the coupled circuits can be integrated into the same substrate by using a semiconductor or a dielectric body having a low light-absorption loss composition. Such a structure has advantage in ease of adjustment in manufacturing and stability in displacement.

As explained above, by the present invention, a method to extract a data signal from a relatively simply structured light transmission path at some point along the path and its device can be manufactured with fast response speed and with no insertion loss.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a diagram indicating the theory for the method to extract the data signal from the light transmission path at some point along the path. Fig. 1 shows a diagram of the device as one embodiment example used for the method to extract the data signal from the light transmission path at some point along the path.

1, 4, 11a, 11b. Laser light

2, 12a, 12b. Coupled circuits

3. Active waveguide path

10a, 10b. Light transmission path

13. Switching circuit

14. Reverse bias charging circuit

15. Terminal

16. Forward bias charging circuit

Translations
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